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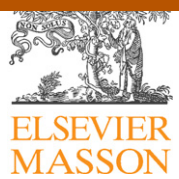

CLINICAL RESEARCH

Trends in plasma lipids, lipoproteins and dyslipidaemias in French adults, 1996—2007

Évolution des lipides, des lipoprotéines et des dyslipidémies des adultes français, 1996—2007

Jean Ferrières[a,*], Vanina Bongard[a], Jean Dallongeville[b], Dominique Arveiler[c], Dominique Cottel[b], Bernadette Haas[c], Aline Wagner[c], Philippe Amouyel[b], Jean-Bernard Ruidavets[a]

[a] *Inserm U558, department of epidemiology and department of cardiology B, Toulouse university hospital, Toulouse, France*
[b] *Inserm U744, department of epidemiology and public health, Pasteur Institute of Lille, Lille, France*
[c] *Department of epidemiology and public health, medical faculty, Louis-Pasteur university of Strasbourg, EA 3430, Strasbourg, France*

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KEYWORDS
Population;
LDL-cholesterol;
Representative survey;
Lipid-lowering drugs

Summary
Background. — In France, the reported decrease in cardiovascular death is due partly to improved cardiovascular prevention. The management of dyslipidaemias remains a priority of preventive cardiology.
Aim. — To assess trends in lipids, lipoproteins and dyslipidaemias between 1996 and 2007 in France.
Methods. — Representative surveys of the general population were carried out in Lille, Strasbourg and Toulouse during two periods, 1996 to 1997 and 2006 to 2007. Men and women aged 35 to 64 years were included. Investigators recorded cardiovascular risk factors, and a blood sample was drawn to measure glycaemia and to provide a complete lipid profile. The data were corrected according to the respective original populations to study 10-year trends in the parameters measured.

* Corresponding author. Service de cardiologie B, CHU Rangueil, TSA 50032, 31059 Toulouse cedex 9, France.
E-mail address: ferrieres.j@chu-toulouse.fr (J. Ferrières).

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Results. — From 1996 to 2007, a significant 5.7% decrease in low-density lipoprotein (LDL)-cholesterol levels was observed in adults aged 35 to 64 years ($p < 0.001$). This decrease was greater in those aged 55 to 64 years (10.8% in men, 8.4% in women). A significant 7.8% increase in triglycerides was observed ($p < 0.001$) over the same period. Variation in LDL-cholesterol was more striking in subjects treated with a lipid-lowering drug, with a 17.6% reduction ($p < 0.001$). A decrease in most of dyslipidaemias was also observed over this 10-year interval.
Conclusion. — This study shows a favourable downward trend in LDL-cholesterol concentration and dyslipidaemias in France. The significant decrease in LDL-cholesterol observed among all the subjects and more particularly among subjects treated with lipid-lowering drugs should provide an incentive for physicians to support the management of all French adults.

MOTS CLÉS
Population ;
LDL-cholestérol ;
Étude représentative ;
Hypolipidémiant

Résumé
Contexte. — L'amélioration de la prévention cardiovasculaire a contribué à la baisse de la mortalité cardiovasculaire en France. La prise en charge des dyslipidémies fait partie des priorités de la cardiologie préventive. Le but de ce travail a été d'évaluer l'évolution des lipides, des lipoprotéines et des dyslipidémies de 1996 à 2007 en France.
Méthodes. — Deux enquêtes représentatives de la population générale ont été réalisées dans les régions de Lille, Strasbourg et Toulouse en 1996 à 1997 et en 2006 à 2007. Ces deux enquêtes ont inclus des hommes et des femmes de 35 à 64 ans. Les enquêteurs ont recueilli l'ensemble des facteurs de risque cardiovasculaire et une prise de sang a été réalisée pour évaluer la glycémie et le bilan lipidique complet. Les données ont été redressées sur les populations d'origine de façon à étudier l'évolution à dix ans des paramètres mesurés.
Résultats. — De 1996 à 2007, le LDL-cholestérol chez les sujets adultes de 35 à 64 ans a baissé significativement de 5,7 % ($p < 0,001$). Cette baisse a été plus marquée dans la tranche d'âge de 55 à 64 ans (10,8 % chez les hommes et 8,4 % chez les femmes). Durant la même période, on a enregistré une augmentation significative de 7,8 % des triglycérides ($p < 0,001$). La baisse du LDL-cholestérol a été beaucoup plus marquée chez les sujets traités par un hypolipidémiant avec une baisse de 17,6 % ($p < 0,001$). La plupart des dyslipidémies a diminué significativement à dix ans d'intervalle.
Conclusion. — Cette étude montre une évolution favorable du LDL-cholestérol et des dyslipidémies en France. La baisse significative du LDL-cholestérol enregistrée chez l'ensemble des sujets et plus particulièrement chez les sujets traités par un hypolipidémiant doit encourager les médecins à une prise en charge de la population française adulte.

Abbreviations

HDL	high-density lipoprotein
LDL	low-density lipoprotein
SE	standard error

Background

Cardiovascular diseases are chronic conditions whose management and prognosis have evolved significantly in recent years. Primary and secondary prevention practices have improved, with better screening of risk factors in patients with minor coronary atherosclerosis and with treatment of patients with chronic disease. Hence, death due to cardiovascular diseases in France has decreased by 52% between 1980 and 2004 [1].

While improved management of acute forms of cardiovascular diseases will continue, only systematic treatment of risk factors will prevent new cases of coronary artery disease from occurring. Management of tobacco consumption, hypercholesterolemia, high blood pressure and diabetes form the fundamental basis for cardiovascular prevention. Control of high blood pressure has been a concern for a long time, but the aggressive treatment of hypercholesterolemia is a relatively recent priority in France [2]. A great number of industrialized countries have set targets for blood pressure, cholesterolaemia values and other risk factors [3]. This is also the case in France, where precise objectives concerning the control of the various risk factors have been stipulated in Public Health law [4].

To assess trends in risk factors in France, representative surveys of the general population are needed. Since 1985, the French Multinational MONItoring of trends and determinants in CArdiovascular disease (MONICA) Project has carried out a continuous survey of coronary artery disease in France and assessed classical risk factors for coronary atherosclerosis through representative surveys of the French population [5]. The aim of this work was to assess trends in lipids, lipoproteins and dyslipidaemias between 1996 and 2007 from representative surveys of the French population.

Methods

Population sample

Participants were recruited in the framework of the World Health Organization MONICA population survey [6—9], conducted between 1996 and 1997, and in the MONA LISA survey, carried out between 2006 and 2007 [10], in three different parts of France: the Lille Urban Community in Northern France, the Bas-Rhin county in Eastern France and the Haute-Garonne county in Southern France. The protocol was approved by the appropriate independent ethics committees. Subjects (aged 35—64 years in the first survey and 35—74 years in the second) were selected randomly from electoral rolls after stratification by town size, sex and age, in order to obtain 200 participants for each sex and each 10-year age group, with the same sampling frame in the two surveys. Participation rates were 63% for men and 60% for women in the first survey, and 50% for men and 51% for women in the second survey. A total of 4195 men and 4106 women completed the recruitment procedure.

Data collection

After providing written informed consent, participants filled out a standard questionnaire and physical measurements were taken by a specially trained nurse. An identical methodology was used in the three centres and in the two surveys. Subjects provided information on demographic variables, socioeconomic status and medical history including medication use, smoking and alcohol consumption using a questionnaire, which was completed with the help of medical staff. A physical examination was performed in the morning and a fasting blood sample was drawn. The level of leisure-time physical activity was categorized as follows: none, light (light physical activity almost every week), or intense (at least 20 minutes of intense physical activity more than once a week). In terms of smoking exposure, subjects were categorized as never-smokers, former smokers and current smokers (i.e., subjects reporting at least one cigarette per day). Total alcohol intake was expressed as the sum of milliliter alcohol per week from wine, beer, cider and spirits. Anthropometric measurements included height, body weight (rounded to the nearest even decimal) and waist circumference (at a mid level between the lower rib margin and the iliac crest, to the nearest 0.5 cm), and were performed in subjects in light clothing without shoes. Body mass index was calculated according to the Quetelet equation.

Blood pressure measurements were performed with a standard sphygmomanometer (OMRON 705IT) using cuff size adapted to the subject's arm circumference. Heart rate and blood pressure were measured twice with the patient in the sitting position. The average of the two blood pressure measurements was used for statistical analysis.

Biological measurements

A 20-ml blood sample was drawn into a disodium EDTA tube (after the subjects had fasted for at least 10 hours), stored at room temperature and centrifuged within 4 hours. All measurements were performed in a central laboratory (Toulouse University Hospital in 1996-1997 and Pasteur Institute of Lille in 2006—2007, France). Cholesterol and triglyceride concentrations were measured using enzyme assays (Olympus). High-density lipoprotein (HDL) cholesterol was measured after sodium phosphotungstate/magnesium chloride precipitation (Olympus). Glucose was measured using the standard glucose hexokinase method (DuPont Dimension, Brussels, Belgium). Low-density lipoprotein (LDL) cholesterol was determined by the Friedewald equation only if triglycerides levels were lower than 4.56 mmol/l (4 g/l).

Statistical analysis

High LDL-cholesterol was defined as LDL-cholesterol greater than 4.1 mmol/l (1.60 g/l). High triglycerides were defined as triglycerides greater or equal to 2.3 mmol/l (2 g/l). Low HDL-cholesterol was defined as HDL-cholesterol less than 1.05 mmol/l (0.40 g/l) in men or less than 1.30 mmol/l (0.50 g/l) in women. Prevalence of hypercholesterolaemia was defined as patients on lipid-lowering treatment or patients with LDL-cholesterol greater than 4.1 mmol/l (1.60 g/l) or, if triglycerides greater than 4.56 mmol/l (4 g/l), patients with total cholesterol greater than 6.45 mmol/l (2.5 g/l).

Percentages or means and standard errors were given for each table. Means and percentages of the finite population were estimated from survey data considering the stratification sample design by age, sex and region. Estimates were obtained by computing weighted averages of the individual stratum-specific estimates and aggregating them across strata [11]. Standard errors of the means or percentages were estimated taking into account the sample weights and sample design by using Taylor series linearization [12]. The variation in the levels of each plasma lipid parameter between the two population surveys was analysed using the Wald test. For serum triglycerides, analyses were performed after logarithmic transformation because of a highly skewed distribution; variation of population means between the first and the second survey was calculated using geometric mean values. A p value < 0.05 was considered to be statistically significant. Data analyses were performed with Stata release 9.2 [13].

Results

A total of 3508 subjects were included in the first survey (1996—1997) and 4793 in the second (2006—2007). In the latter, subjects in the age range 65—74 years (n = 1196) were also included but were not taken into account in this paper. All the data obtained from the population samples were corrected according to the respective original populations. The main risk factors and their trends over the 10-year interval are presented in Table 1. A significant decrease in tobacco consumption and in systolic and diastolic blood pressures was observed whereas body mass index and waist circumference remained stable. The use of lipid-lowering drugs increased significantly from 10.4 to 12.5% in the general population (p = 0.004).

Trends in concentrations of the various lipoproteins over the 10-year interval are presented in Table 2. These data show a significant 5.7% decrease in LDL-cholesterol

Table 1 Baseline demographics, risk factors and medical history in French adults (aged 35—64 years) in 1996—1997 and in 2006—2007.

Characteristics	1996—1997 ($n = 3508$)	2006—2007 ($n = 3597$)	p
Body mass index (kg/m^2)[a]	26.2 ± 0.08	26.1 ± 0.08	0.48
Waist circumference (cm)[a]	89.6 ± 0.22	89.3 ± 0.21	0.32
Systolic blood pressure (mmHg)[a]	131.3 ± 0.31	129.5 ± 0.28	0.001
Diastolic blood pressure (mmHg)[a]	82.1 ± 0.20	80.6 ± 0.17	0.001
Current smoker[b]	22.1 (20.6—23.5)	18.9 (17.6—20.2)	0.002
Current hypoglycaemic drug[b]	3.5 (3.0—4.1)	3.4 (2.9—4.0)	0.78
Hypercholesterolaemia[b,c]	41.7 (40.1—43.3)	36.9 (35.3—38.4)	0.001
Current lipid-lowering drug[b]	10.4 (9.4—11.3)	12.5 (11.5—13.5)	0.004
Subjects without dyslipidaemia[b,d]	45.0 (43.1—46.5)	51.5 (49.7—52.9)	0.001
Medical history			
Coronary artery disease[b]	2.53 (2.05—3.01)	2.08 (1.63—2.52)	0.18
Peripheral artery disease[b]	0.94 (0.64—1.23)	0.69 (0.44—0.94)	0.22
Stroke[b]	0.64 (0.40—0.89)	0.62 (0.38—0.87)	0.89
Chronic kidney disease[b]	0.08 (0.01—0.16)	0.12 (0.01—0.23)	0.51
Cancer[b]	1.46 (1.09—1.84)	3.59 (3.00—4.17)	0.001

[a] Mean ± standard error.
[b] Percent (95% confidence interval).
[c] LDL-cholesterol > 4.1 mmol/l (1.60 g/l) or (triglycerides > 4.56 mmol/l (4 g/l) and total cholesterol > 6.45 mmol/l (2.5 g/l) or treatment.
[d] Subjects without lipid-lowering drug and with LDL-cholesterol < 4.1 mmol/l (1.60 g/l) and triglycerides < 2.3 mmol/l (2 g/l) and HDL-cholesterol > 1.05 mmol/l (0.40 g/l) in men or HDL-cholesterol > 1.30 mmol/l (0.50 g/l) in women.

($p < 0.001$) between 1996 and 2007. This decrease was more marked in patients aged 55—64 years (10.8% in men and 8.4% in women). A more moderate 1.9% decrease was observed for HDL-cholesterol ($p < 0.003$). Moreover, a significant 7.8% increase in the geometric mean of triglycerides was observed ($p < 0.001$).

When the analysis of lipid trends was performed taking into account subjects treated or not treated with lipid-lowering drugs, the magnitude of variation was entirely different (Table 3). In untreated subjects, the decrease in LDL-cholesterol was 4.1% ($p < 0.001$) whereas it reached 17.6% ($p < 0.001$) in treated subjects. Moreover, a significant variation was observed in use of lipid-lowering drugs in dyslipidaemic subjects. During the period 1996—1997, 33.7% of the dyslipidaemic subjects were treated with statins whereas this rate reached 71.8% during the period 2006—2007. Conversely, treatment with fibrates decreased from 54.1% during the period 1996—1997 to 16.8% during the period 2006—2007. In 2006—2007, atorvastatin was the most commonly prescribed statin (35.8% of all statins) whereas the most common fibrate was fenofibrate (87.2% of all fibrates). In the two representative surveys, 12.2% (1996—1997) to 11.4% (2006—2007) of subjects received lipid-lowering drugs other than statins and fibrates.

The prevalence of the different dyslipidaemias over the 10-year interval is presented in Fig. 1. We observed a significant decrease in the prevalence of pure hypercholesterolaemia, of isolated low HDL-cholesterol and of the combination of low HDL-cholesterol with high LDL-cholesterol. Conversely, we observed a significant increase in the combination of hypertriglyceridaemia with high LDL-cholesterol over the 10-year interval. When we excluded subjects treated with lipid-lowering drugs, the same trends were shown in the prevalence of the different dyslipidaemias over the 10-year interval (Fig. 2), except for the combination of hypertriglyceridaemia with high LDL-cholesterol, which was not significant.

Discussion

In this study, we observed a favourable 6% downward trend in LDL-cholesterol concentrations in France over a 10-year interval. The decrease in LDL-cholesterol was more pronounced in subjects treated with lipid-lowering drugs. Moreover, French physicians' practice showed changing patterns, since statins was the most commonly lipid-lowering drugs used in the most recent survey. Lastly, the prevalence of the different dyslipidaemias decreased significantly between 1996 and 2007.

Agreement between physicians and policy makers concerning the management of LDL-cholesterol is relatively recent. The beneficial impact of statins on total mortality in secondary [14] and primary [15,16] prevention had to be demonstrated before radical changes in patients' management could be achieved. As soon as the efficacy of lipid-lowering drugs on cardiovascular prognosis and life expectancy had been demonstrated, it induced massive adherence from both prescribers and patients. Observations of lipid trends are relatively scarce because representative studies of the general population are needed to obtain a reliable picture of these changes. In the USA, two major studies [17,18] showed a favourable trend in total cholesterol concentrations during recent years. In European population studies, it seems that the trend in LDL-cholesterol decreased in a similar way [19,20]. This favourable trend seems to be confirmed despite the unfavourable trend in obesity observed in some countries [21].

Table 2 Trends in lipids and lipoproteins in French adults (35–64 years) between 1996–1997 and 2006–2007.

	1996–1997 ($n = 3508$)	2006–2007 ($n = 3597$)	%[b]	p
	Mean ± SE[a] (mmol/l)(g/l)			
Total cholesterol				
Total population (35–64 years)	5.88 ± 0.02 (2.28 ± 0.007)	5.68 ± 0.02 (2.20 ± 0.007)	−3.5	0.001
Men				
35–64 years	5.93 ± 0.03 (2.30 ± 0.01)	5.73 ± 0.03 (2.22 ± 0.01)	−3.5	0.001
35–44 years	5.83 ± 0.05 (2.26 ± 0.02)	5.68 ± 0.05 (2.2 ± 0.02)	−2.5	0.02
45–54 years	6.01 ± 0.05 (2.33 ± 0.02)	5.83 ± 0.05 (2.26 ± 0.02)	−2.9	0.004
55–64 years	6.04 ± 0.05 (2.34 ± 0.02)	5.62 ± 0.05 (2.18 ± 0.02)	−6.7	0.001
Women				
35–64 years	5.83 ± 0.03 (2.26 ± 0.01)	5.65 ± 0.02 (2.19 ± 0.009)	−3.5	0.001
35–44 years	5.44 ± 0.05 (2.11 ± 0.02)	5.31 ± 0.05 (2.06 ± 0.02)	−2.1	0.04
45–54 years	5.96 ± 0.05 (2.31 ± 0.02)	5.70 ± 0.05 (2.21 ± 0.02)	−4.1	0.001
55–64 years	6.35 ± 0.05 (2.46 ± 0.02)	6.04 ± 0.05 (2.34 ± 0.02)	−5.2	0.001
LDL-cholesterol				
Total population (35–64 years)	3.84 ± 0.02 (1.49 ± 0.007)	3.61 ± 0.02 (1.40 ± 0.006)	−5.7	0.001
Men				
35–64 years	3.95 ± 0.03 (1.53 ± 0.01)	3.72 ± 0.02 (1.44 ± 0.009)	−6.3	0.001
35-44 years	3.90 ± 0.05 (1.51 ± 0.02)	3.72 ± 0.05 (1.44 ± 0.02)	−4.3	0.005
45–54 years	4.02 ± 0.05 (1.56 ± 0.02)	3.79 ± 0.05 (1.47 ± 0.02)	−5.8	0.001
55–64 years	4.00 ± 0.05 (1.55 ± 0.02)	3.59 ± 0.05 (1.39 ± 0.02)	−10.8	0.001
Women				
35–64 years	3.72 ± 0.03 (1.44 ± 0.01)	3.51 ± 0.02 (1.36 ± 0.008)	−5.1	0.001
35–44 years	3.38 ± 0.05 (1.31 ± 0.02)	3.28 ± 0.05 (1.27 ± 0.02)	−3.0	0.05
45–54 years	3.77 ± 0.05 (1.46 ± 0.02)	3.56 ± 0.05 (1.38 ± 0.02)	−5.3	0.001
55–64 years	4.15 ± 0.05 (1.61 ± 0.02)	3.79 ± 0.05 (1.47 ± 0.02)	−8.4	0.001
HDL-cholesterol				
Total population (35–64 years)	1.50 ± 0.01 (0.58 ± 0.003)	1.47 ± 0.01 (0.57 ± 0.002)	−1.9	0.003
Men				
35–64 years	1.32 ± 0.01 (0.51 ± 0.003)	1.32 ± 0.01 (0.51 ± 0.003)	+0.6	0.94
35–44 years	1.32 ± 0.02 (0.51 ± 0.006)	1.32 ± 0.02 (0.51 ± 0.006)	−0.8	0.61
45–54 years	1.32 ± 0.02 (0.51 ± 0.006)	1.32 ± 0.02 (0.51 ± 0.006)	−0.6	0.68
55–64 years	1.34 ± 0.02 (0.52 ± 0.006)	1.34 ± 0.02 (0.52 ± 0.006)	−0.4	0.78

Table 2 (*Continued*)

	1996–1997 ($n = 3508$)	2006–2007 ($n = 3597$)	%[b]	p
	Mean ± SE[a] (mmol/l)(g/l)			
Women				
35–64 years	1.65 ± 0.01 (0.64 ± 0.004)	1.60 ± 0.01 (0.62 ± 0.003)	−2.2	0.001
35–44 years	1.63 ± 0.02 (0.63 ± 0.006)	1.57 ± 0.02 (0.61 ± 0.006)	−1.8	0.18
45–54 years	1.70 ± 0.02 (0.66 ± 0.006)	1.60 ± 0.02 (0.62 ± 0.006)	−5.7	0.001
55–64 years	1.68 ± 0.02 (0.65 ± 0.006)	1.63 ± 0.02 (0.63 ± 0.006)	−2.9	0.06
Triglycerides				
Total population (35–64 years)	1.31 ± 0.02 (1.15 ± 0.02)	1.38 ± 0.02 (1.21 ± 0.02)	+7.8[c]	0.001
Men				
35–64 years	1.53 ± 0.03 (1.34 ± 0.03)	1.61 ± 0.03 (1.41 ± 0.03)	+7.2	0.001
35–44 years	1.49 ± 0.05 (1.31 ± 0.04)	1.47 ± 0.05 (1.29 ± 0.04)	−1.3	0.39
45–54 years	1.60 ± 0.05 (1.40 ± 0.04)	1.73 ± 0.05 (1.52 ± 0.04)	+10.7	0.003
55–64 years	1.53 ± 0.05 (1.34 ± 0.04)	1.62 ± 0.05 (1.42 ± 0.04)	+8.9	0.009
Women				
35–64 years	1.08 ± 0.02 (0.95 ± 0.02)	1.15 ± 0.01 (1.01 ± 0.01)	+8.7	0.001
35–44 years	0.96 ± 0.05 (0.84 ± 0.04)	0.99 ± 0.05 (0.87 ± 0.04)	+4.0	0.09
45–54 years	1.19 ± 0.05 (1.04 ± 0.04)	1.20 ± 0.05 (1.05 ± 0.04)	+9.4	0.003
55–64 years	1.16 ± 0.05 (1.02 ± 0.04)	1.32 ± 0.05 (1.16 ± 0.04)	+13.1	0.001

[a] SE: standard error.
[b] % of variation between 1996 and 2007.
[c] Trend for the geometric mean.

Our work presents some specificity due to French medical practice. In 1996–1997, fibrates were the most commonly prescribed lipid-lowering drugs, whereas in 2006–2007, statin prescription has become the rule and fibrate use declined to 16.8%. During the same period, we observed a very moderate decrease in HDL-cholesterol (0.57 vs 0.58 g/l) and a significant increase in triglycerides of about 8% (1.21 vs 1.15 g/l). Therefore, we registered mainly an increase in triglycerides that was not explained by body mass index, which remained stable between the two surveys. Despite this a priori unfavourable trend regarding the two parameters, the prevalence of most dyslipidaemias decreased significantly between the two periods. Dyslipidaemias decreased in the whole sample, and also after excluding patients on lipid-lowering drugs, reinforcing a true improvement in this risk factor in the second survey. The combination of high triglycerides with high LDL-cholesterol was the only dyslipidaemia to show a significant increase from 1.8 to 3.1% between the two periods.

In subjects treated with lipid-lowering drugs, we observed a 17.6% decrease in LDL-cholesterol and a 16.6% increase in triglycerides. This change may have been induced by changes in prescription of lipid-lowering drugs, since statins lead to a significant decrease in LDL-cholesterol but poorer control of triglycerides compared with fibrates. In fact, the trend in triglycerides in subjects not treated with lipid-lowering drugs was less significant (6.3% increase in untreated subjects vs 16.6% in treated subjects). Furthermore, the trend in the combination of hypertriglyceridaemia with high LDL-cholesterol was not significant after having excluded subjects on lipid-lowering drugs. Thus, we interpret the variation in HDL-cholesterol and triglycerides as a consequence of the shift in lipid-lowering drugs at a population level. Finally, the prevalence of subjects without dyslipidaemia (globally and in samples not on lipid-lowering drugs) increased significantly between the two surveys, suggesting a real impact of primary prevention on lipid levels in France.

Table 3 Lipids and lipoproteins in treated and non-treated French adults (35–64 years) between 1996–1997 and 2006–2007.

	1996–1997 ($n = 3508$)	2006–2007 ($n = 3597$)	%[b]	p
	Mean ± SE[a] (mmol/l) (g/l)			
Adults treated with lipid-lowering drugs				
Total cholesterol	6.19 ± 0.05 (2.4 ± 0.02)	5.47 ± 0.05 (2.12 ± 0.02)	−11.6	0.001
LDL-cholesterol	4.08 ± 0.05 (1.58 ± 0.02)	3.35 ± 0.05 (1.3 ± 0.02)	−17.6	0.001
HDL-cholesterol	1.44 ± 0.02 (0.56 ± 0.008)	1.37 ± 0.02 (0.53 ± 0.006)	−5.2	0.006
Triglycerides	1.49 ± 0.05 (1.31 ± 0.04)	1.71 ± 0.05 (1.5 ± 0.04)	+16.6[c]	0.001
Adults not treated with lipid-lowering drugs				
Total-cholesterol	5.86 ± 0.02 (2.27 ± 0.007)	5.70 ± 0.02 (2.21 ± 0.007)	−2.4	0.001
LDL-cholesterol	3.82 ± 0.02 (1.48 ± 0.007)	3.64 ± 0.02 (1.41 ± 0.006)	−4.1	0.001
HDL-cholesterol	1.50 ± 0.01 (0.58 ± 0.003)	1.47 ± 0.01 (0.57 ± 0.002)	−1.3	0.10
Triglycerides	1.29 ± 0.02 (1.13 ± 0.02)	1.33 ± 0.02 (1.17 ± 0.02)	+6.3[c]	0.001

[a] SE: standard error.
[b] % of variation between 1996 and 2007.
[c] Trend for the geometric mean.

Our work has several limitations. The surveys were carried out in three highly contrasted regions, which may not be representative of the whole of France. Even though the distributions by age and sex of the three regions were similar, socioeconomic disparities exist between different French regions and risk factors may differ between our surveys and the French population at large. Furthermore, only one plasma lipid measurement was performed in each survey and this may not represent an entirely reliable picture of the patients' basic biological values. This is particularly true

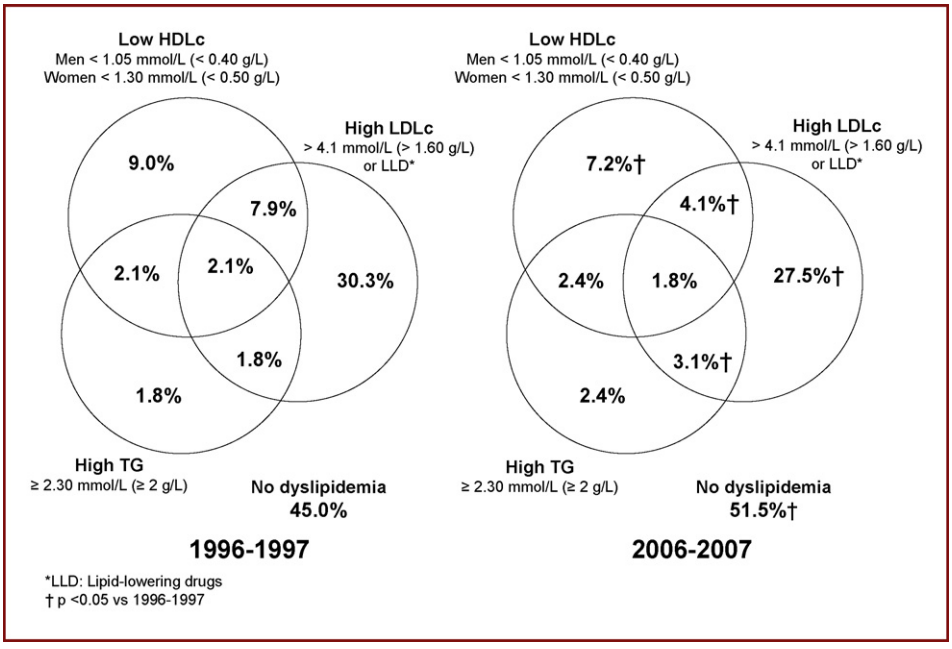

Figure 1. Trends in the prevalence of dyslipidaemias between 1996–1997 and 2006–2007 in French adults aged 35–64 years.

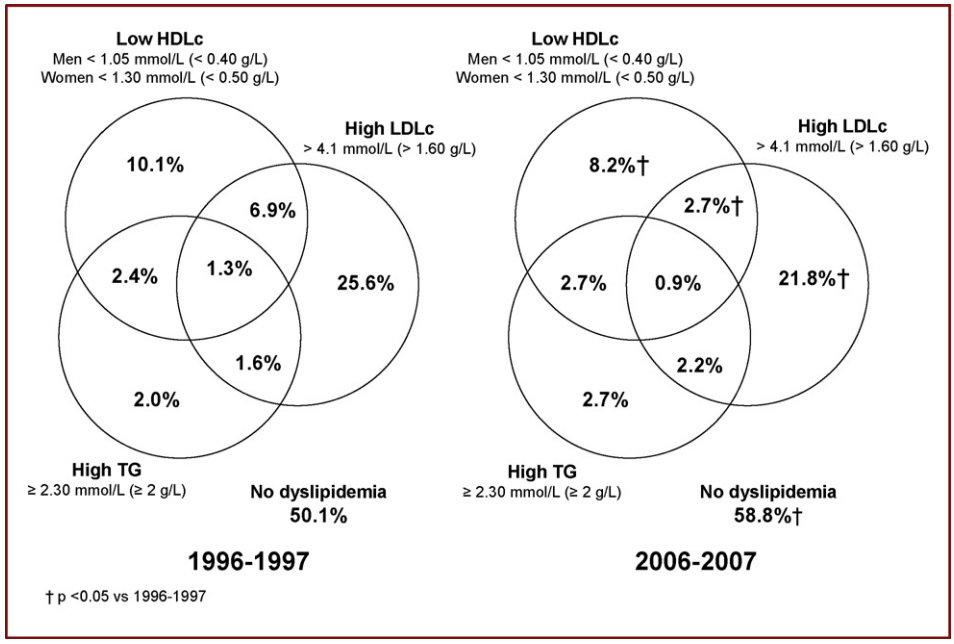

Figure 2. Trends in the prevalence of dyslipidaemias between 1996—1997 and 2006—2007 in French adults aged 35—64 years not treated with lipid-lowering drugs.

for triglycerides and HDL-cholesterol levels, where a stable lifestyle is required to obtain representative parameters. However, all biological examinations were centralized in the same laboratory for each survey and, as far as we know, no similar study has ever been carried out in France. Lastly, as in all population studies, our work may present selection bias. The most seriously affected patients, such as the less educated and the most underprivileged, may not have participated. Therefore, our results might offer an optimistic evaluation of lipid management in France. Further studies will be needed to ensure that these favourable trends in lipid levels remain constant throughout time in France.

Conclusions

Our study shows a favourable trend in LDL-cholesterol levels in France at a population level. This improvement is observed in the whole population but is more significant in subjects treated with lipid-lowering drugs. A widespread promotion of preventive messages and treatment with lipid-lowering drugs in agreement with current recommendations should be intensified to reduce cardiovascular morbidity and mortality.

Conflict of interest: none.

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References

[1] Aouba A, Péquignot F, Le Toullec A, Jougla E. Les causes médicales de décès en France en 2004 et leur évolution (1980-2004). BEH 2007:308—14 [n° 35—36].

[2] Prise en charge thérapeutique du patient dyslipidémique. AFSSAPS 2005.

[3] Graham I, Atar D, Borch-Johnsen K, et al. European Society of Cardiology (ESC); European Association for Cardiovascular Prevention and Rehabilitation (EACPR); Council on Cardiovascular Nursing; European Association for Study of Diabetes (EASD); International Diabetes Federation Europe (IDF-Europe); European Stroke Initiative (EUSI); Society of Behavioural Medicine (ISBM); European Society of Hypertension (ESH); WONCA Europe (European Society of General Practice/Family Medicine); European Heart Network (EHN); European Atherosclerosis Society (EAS). European guidelines on cardiovascular disease prevention in clinical practice: full text. Fourth Joint Task Force of the European Society of Cardiology and other societies on cardiovascular disease prevention in clinical practice (constituted by representatives of nine societies and by invited experts). Eur J Cardiovasc Prev Rehabil 2007;14(Suppl. 2):S1—113.

[4] LOI n° 2004-806 du 9 août 2004 relative à la politique de santé publique. NOR: SANX0300055L.
[5] Marques-Vidal P, Ruidavets JB, Amouyel P, et al. Change in cardiovascular risk factors in France (1985—1997). Eur J Epidemiol 2004;19:25—32.
[6] Ferrières J, Cambou JP, Ruidavets JB, Pous J. Trends in acute myocardial infarction prognosis and treatment in Southwestern France between 1985 and 1990 (The MONICA Project-Toulouse). Am J Cardiol 1995;75:1202—5.
[7] Marques-Vidal P, Ruidavets JB, Cambou JP, Ferrières J. Impact of incidence, recurrence and case-fatality rates of myocardial infarction in coronary heart disease mortality in Southwestern France (1985—1993). Heart 2000;84:171—5.
[8] Ruidavets JB, Bataille V, Dallongeville J, et al. Alcohol intake and diet in France, the prominent role of lifestyle. Eur Heart J 2004;25:1153—62.
[9] Ferrières J, Ruidavets JB, Perret B, et al. Prévalence des dyslipidémies dans un échantillon représentatif de la population française. Arch Mal Coeur Vaiss 2005;98:127—32.
[10] Wagner A, Arveiler D, Ruidavets JB, et al. États des lieux sur l'hypertension artérielle en France en 2007 — Étude Mona Lisa. BEH 2008;49—50:483—6.
[11] Lemeshow S, Levy PS. Sampling of populations: methods and applications. Third Edition New York: John Wiley & Sons Inc; 1999.
[12] Shah BV. Linearization methods of variance estimation. In: Armitage P, Colton T, editors. Encyclopedia of Biostatistics. Vol 3. New York, NY: John Wiley and Sons, Inc; 1998. p. 2276—9.
[13] Stata Statistical Software 9.2 (Stata Corp., College Station, TX, Texas).
[14] Randomised trial of cholesterol lowering in 4444 patients with coronary heart disease: the Scandinavian Simvastatin Survival Study (4S). Lancet 1994;344:1383—1389.
[15] Mills EJ, Rachlis B, Wu P, Devereaux PJ, Arora P, Perri D. Primary prevention of cardiovascular mortality and events with statin treatments: a network meta-analysis involving more than 65,000 patients. J Am Coll Cardiol 2008;52:1769—81.
[16] Ridker PM, Danielson E, Fonseca FA, et al. Jupiter Study Group. Rosuvastatin to prevent vascular events in men and women with elevated C-reactive protein. N Engl J Med 2008;359:2195—207.
[17] Carroll MD, Lacher DA, Sorlie PD, et al. Trends in serum lipids and lipoproteins of adults, 1960—2002. JAMA 2005;294:1773—81.
[18] Arnett DK, Jacobs Jr DR, Luepker RV, Blackburn H, Armstrong C, Claas SA. Twenty-year trends in serum cholesterol, hypercholesterolemia, and cholesterol medication use: the Minnesota Heart Survey, 1980—1982 to 2000—2002. Circulation 2005;112:3884—91.
[19] Eliasson M, Janlert U, Jansson JH, Stegmayr B. Time trends in population cholesterol levels 1986—2004: influence of lipid-lowering drugs, obesity, smoking and educational level. The northern Sweden MONICA study. J Intern Med 2006;260:551—9.
[20] Grau M, Subirana I, Elosua R, et al. Trends in cardiovascular risk factor prevalence (1995—2000—2005) in northeastern Spain. Eur J Cardiovasc Prev Rehabil 2007;14:653—9.
[21] Hobbs MS, Knuiman MW, Briffa T, Ngo H, Jamrozik K. Plasma cholesterol levels continue to decline despite the rising prevalence of obesity: population trends in Perth, Western Australia, 1980—1999. Eur J Cardiovasc Prev Rehabil 2008;15:319—24.